REPORT OF SUBCOMMITTEE G ON EXPOSURE METERS*

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A proposed American War Standard Specification for Exposure Meters has been drawn up as a part of the standardization activities of the War Committee on Photography and Cinematography-Z52. The Z52 American War Standards Subcommittee *G*, under the Chairmanship of Mr. F. K. McCune, undertook this work at the request of Capt. Lloyd T. Goldsmith, Signal Corps, who is Chairman of the Armed Forces Committee on Photography and Cinematography.

The Armed Forces in the past have purchased exposure meters which, for the most part, have been of the commercial type, designed essentially for peace-time applications. Reports from the field have indicated that not all of these meters have successfully fulfilled the rigid requirements of the armed services in battle areas in all parts of the world. This fact made it imperative to consider the service requirements for exposure meters and to draw up a specification that would cover a standard type of meter which would be entirely acceptable, from the standpoint of construction and performance, to all branches of the service.

Such a specification has been drawn up by members of industry in cooperation with representatives of the armed services, and it is hoped that this specification will be approved as a joint Army-Navy specification and used first as a development specification, and ultimately as a basis for procurement of production units.

The work of this Subcommittee began by deciding upon a method of light measurement and maximum sensitivity. It was decided that the new exposure meter should be of the general-purpose type designed to operate on the principle of reflected light, in order to be adapted to all types of military use. The maximum sensitivity de-

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sired for such a general-purpose instrument was defined as "an instrument whose pointer would deflect at least 0.010 in. for an exposure of $f/11$ with a shutter speed of 1 sec and a film speed number of 100, when used by the reflected light method." This represented less sensitivity than had been previously supplied by most manufacturers, but this change was felt fully justified, since it would enable them to make more sturdy devices which would be necessary to meet the performance specifications which were to follow.

The over-all performance of the device was next considered. An exposure meter is essentially a sensitive microammeter used in combination with a light-sensitive cell of the barrier-layer type, equipped with a suitable light-restricting mechanism over the cell, and a calculator by which exposure can be determined. In view of this, it was felt that the basic mechanism should meet performance specifications similar to those which were set up recently for small panel-type indicating instruments. The American War Standard for Small Panel Instruments, C39.2-1944, was therefore used as a basis for making up this proposed American War Standard for Exposure Meters.

In this proposed standard, careful consideration has been given to the mechanical construction and electrical performance. From the standpoint of mechanical construction, the case design must be dust-tight and moisture-proof, all component parts will be required to be adequately protected against rust and corrosion when subjected to all types of world climatic conditions, moving systems will be balanced within closer limits, and ready means of instrument adjustment will be required. The calculators will be designed to use standardized f/stops, shutter times, and ASA exposure index speed numbers.

One of the prime purposes of this proposed standard was to set up requirements which would ultimately result in exposure meters made by various manufacturers indicating more nearly the same exposure. To attain this, rigid limits of angle of acceptance, method of calibration, cell spectral sensitivity, and performance were set up.

The angle of acceptance of light energy striking the light-sensitive cell surface was defined, in order to more definitely control the directional characteristics of the device. Essentially this means that some form of hood, barrier, or grid must be placed in front of the cell in such a manner that not less than 60 per cent of the luminous energy actuating the meter from a screen of uniform brightness shall come from an area included within a cone whose half-angle is 25 degrees. Definite test conditions have been set up to insure the conformance of meters to this requirement.

The meter and calculator combination on all makes of exposure meters will be designed to conform with the following law:

$$T = \frac{1.25 f^2}{B \times S} \tag{1}$$

where f = f/stop; B = brightness of a uniform brightness surface as described below in candles per sq ft; S = Exposure Index or ASA Speed Number; and T = Shutter time in sec.

The specific calibration methods used by the various manufacturers will not be specified; however, a uniform brightness screen for a

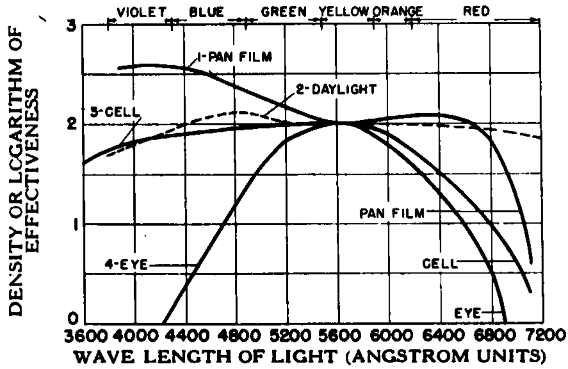

FIG. 1. Color sensitivity of various types of sensitive materials and cell compared with the energy in daylight.

transfer standard has been described in order to insure that all types of meters will conform to the above law for calibration. This uniform brightness screen has been described in general as a good quality pot opal glass illuminated approximately uniformly by a light of equivalent color temperature of between 2680 K to 2820 K at level of 100 to 250 candles per sq ft.

The importance of controlling spectral sensitivity of the light-sensitive cell has been recognized. The response of a typical light cell to light covers a range of wavelengths greater than that of the human eye and less than that of panchromatic film, as may be seen by Fig. 1. After comparing the spectral response of light-sensitive cells available today, an envelope curve was agreed upon which will control this characteristic within adequate working limits. The curve for cell response, as shown in Fig. 1, falls approximately in the center of the allowable envelope as set up in the new specification.

Performance tests, more rigid and more in detail than previously required, have been made a part of this specification and are listed in Table 1, with allowable limits for each test.

In addition to the requirements of shock and vibration tests indicated above, an abuse test has been added to insure that the exposure meters passing the performance tests will be sturdy enough to

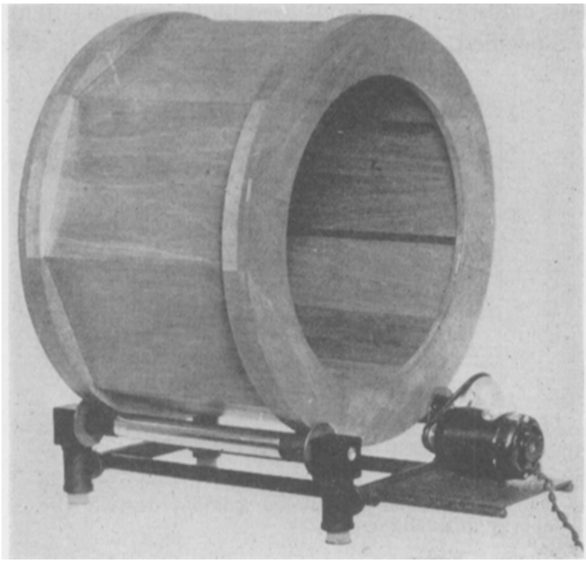

FIG. 2. Abuse-testing mechanism for service-model photographic exposure meters.

withstand the requirements of the services. The tests will be made in an abuse tester which has been standardized for this application. It consists essentially of a tumbling barrel about 15 in. in diameter (see Fig. 2) which will rotate at a speed of 60 rpm. Sample exposure meters will be placed in this barrel and will have to withstand the random shocks of unpredictable acceleration for a period of one minute without becoming inoperative.

Three of the leading exposure meter manufacturers generously contributed their engineering test data and experience on exposure meter design in the making up of this proposed standard. It is felt

TABLE 1

Description of Test	Test Limit (Upper 2/3 Scale)
Initial accuracy	Within 1/3 f/stop
Response time	3 sec max
Temperature influence (±10 C change)	1/6 f/stop max change
Heat effect at +55 C (131 F), 3 cycles	1/3 f/stop max change
Permanent change due to +55 C test	1/3 f/stop max change
Cold effect—perm. error due to −35 C (−31 F) expos.	1/3 f/stop max change
Humidity test of 6 hr at +55 C (131 F) at 95 per cent RH and 18 hr in reducing temp and 100 per cent RH, 2 cycles	1/2 f/stop max change
Effect of vibration at from 500 to 2500 cycles per min at 0.018 in. to 0.020 in. amplitude for 2 hr	1/6 f/stop max change
Pivot friction as a result of vibration	1/3 f/stop max
Effect of shock—50 G (50 times force of gravity), 10 times, 3 directions	1/6 f/stop max change

this work will result in a specification that will cover the requirements for and the performance of exposure meters which will adequately meet the needs of the Armed Forces and also others who use this type of device. This proposed American War Standard should also be of much assistance as a basis for other standards for exposure meters which may be required in the post-war period.